Application No.: 10/025,852 Docket No.: 503.41039X00

REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested.

This Amendment is in response to the Office Action dated January 15, 2004. By the present Amendment, claim 13 has been amended to correct the dependency thereof. Therefore, consideration of claim 13 is respectfully requested. In addition, a new dependent claim 15 has been added to define the same subject as found in claim 13, except for dependence on claim 12 rather than claim 11. In addition, the original independent claims have been amended for clarification, as will be discussed below.

Clarification of the Office Action is also respectfully requested, particularly with regard to the objection regarding claim 14 and the fact that claim 14 was not treated on the merits in the Office Action. Claim 14 is a multiple dependent claim that depends on the independent claims 6, 7, 8 and 9. Therefore, unlike claim 13, claim 14 is not a multiple claim which depends on another multiple dependent claim. Regarding this, it is noted that claim 14 has the same dependency as claims 10-12, in other words, they are all dependent on claims 6-9. Therefore, clarification as to why claim 14 was objected to, or, alternatively, removal of the objection and examination of claim 14 is respectfully requested.

Regarding this matter, it is respectfully submitted that if claim 14 is rejected in the next Office Action, any such Office Action should not be a final rejection. The reason for this is that claim 14 should have been examined with the first Office Action and treated on the merits because it was, in fact, a proper multiple dependent claim. As such, Applicants are entitled to two Office Actions on the merit, which

would not be the case if claim 14 is rejected in the next Office Action and that Office Action is made final.

Briefly, the present invention is directed to specific improvements over fuel injection arrangements previously developed by a number of the inventors. More specifically, Figs. 3-5 of the present application describe a prior art system which was developed by a number of the inventors of the present application, and which was discussed, for example, in the Miyajima document F2000A100 reference relied on as one of the primary references in the Office Action. This Miyajima F2000A100 reference is disclosed in the present specification, beginning on page 17, line 6 et seq., of the Substitute Specification with specific regard to the discussion concerning prior art Figs. 3-5. It is also noted that the other primary reference to Miyajima USP 6,453,872 (hereinafter referred to as the Miyajima patent) is substantially the same arrangement set forth in the Miyajima F2000A100 document.

Turning to this prior art arrangement of Figs. 3-5 of the present application and both Miyajima references, it can be seen that these systems provide an upstream step wall 303 and a downstream step wall 304 that connects to an injection hole inside wall 305. As discussed on page 17, lines 11 et seq. of the Substitute Specification filed on March 11, 2002, the similarity between the prior art and the present invention embodiment of Fig. 2(a) is discussed. Specifically, this similarity lies in the fact that both the prior art arrangement and the embodiment of the present invention includes upper steps (e.g. 301 in the prior art and 201 in the present Fig. 2(a) and (b) embodiment) and lower steps (302 in the prior art and 202 in the present invention). On the other hand, an important difference of the prior art arrangement from the embodiment of the present invention (which will be discussed in greater

detail later) is set forth as follows on page 17, line 18 et seq. of the Substitute Specification:

> "However, the straight line connecting the downstream edge transition portion 306, where the step wall 304 connects to the injection hole inside wall 305, and the upstream edge transition portion 307, where the step wall 303 connects to the injection hole inside wall 305, is made approximately parallel with the step wall 303 that extends from the upstream edge transition portion 307 in a direction away from the injection hole 101."

A visual comparison of the straight line arrangement shown in Fig. 3b shows that this is clearly quite different from the Fig. 2b embodiment, as will be discussed below.

Page 17, line 26 through page 21, line 4 of the Substitute Specification go on to discuss the sprays generated from the prior art arrangements of Figs. 3-5. Page 20, line 10 particularly notes that attempts to generate a thick air-fuel mixture around the injection plug to improve combustion stability leads to problems with the prior art system regarding unburnt fuel. On the other hand, with the prior art system, attempts to direct a thin spray to restrict the unburnt fuel component leads to deteriorating the generation of a thick mixture adjacent the ignition plug, thereby decreasing the combustion stability. Therefore, as stated on page 20, line 25 et seq. of the Substitute Specification:

> "In conclusion, with a fuel injection valve according to the prior art that has the shape of the injection hole opening shown in Figs. 3(a) and 3(b), it is difficult to generate a spray profile that further improves the fuel consumption and an exhaust performance of a direct injection type engine simply by changing the position, which is a design constant, of the step wall 304.

Regarding this, it is noted that this discussion of Figs. 3-5 of the present application, and the above discussed disadvantage, specifically applies to both the Miyajima

references, particularly noting that Figs. 3-5 of the present application specifically illustrate the Miyajima F2000A100 document.

Accordingly, the present invention is directed to an arrangement specifically designed to overcome these prior art problems. With regard to this, references made to Fig. 2a and 2b which shows an overall view of the first embodiment of the present invention, Fig. 6, which shows a detailed view of the vicinity of the injection hole opening, and Fig. 7, which shows an example of a spray pattern that can be generated using the arrangement of Fig. 6.

Referring to Figs. 2a and 2b, and the discussion beginning on page 14 of the Substitute Specification, it can be seen that this embodiment provides an upstream wall 203 and a downstream wall 204 between an upper step 201 and a lower step 202. In conjunction with this, a restriction wall 210 is provided (shown in more detail in Fig. 6) which connects to the upstream wall 203 and the downstream wall 204 at the restriction wall ends 207 and 206, respectively (e.g., see page 14, line 16 et seq.). In more detail, as noted on page 15, lines 14-18, the restriction wall 210 come approximately together with the injection hole inside wall 205 and "can be regarded as part of the inside wall of the injection hole."

A visual comparison of Fig. 2b and the prior art Fig. 3b shows an immediate difference with regard to the location of the step wall 203 of the present invention compared with the location of the step wall 303 of the prior art, as well as differences in the position between the restriction wall and 207 at the point of initiation of the step wall 203 for the present invention compared with the point 307 at which the step wall 303 of the prior art structure. Also, the angular relationship between the step

wall 203 and step wall 204 is much different than the straight line relationship between the walls 303 and 304 of the prior art structure.

The significance of these differences pertains to the effect that the location of the wall 203 and the restriction wall and 207 has on the final spray pattern. Applicants only discovered these relationships after the Miyajima references were developed. Specifically, as noted on page 16, line 22 et seq. of the Substitute Specification:

> "The profile of the spray injected from the fuel injection valve, the injection hole opening of which is designed as stated above, can be adjusted by the positional relations among the afore-mentioned downstream edge transition portion 206, upstream edge transition portion 207 and step wall 203 extending from the upstream edge transition portion 207 towards the outside of the injection hole."

More specifically, as shown in Figs. 6 and 7, the particular relationship between these elements (that is, the walls 203 and 204 and the restriction wall ends where they begin, 207 and 206) permit the generation of a highly desirable fuel spray pattern with a concentrated spray 701 generated by the end 206 (e.g., see page 23, line 11 et seq.) and a thin spray region 702 generated by the upstream step wall 203 and its restriction wall end 207 (e.g., page 25, line 13 et seq.). As such, the setting of the particular relationships between the side walls and their points of initiation (206 and 207) overcomes the problems in locating the concentrated fuel spray and the thin fuel spray portions at the appropriate areas, which problems existed in the prior art arrangements disclosed in Figs. 3-5 and the Miyajima references (noting again that these problems were discussed on page 20, line 10 through page 21, line 4 of the Substitute Specification).

In summary, as discussed above, the specific design of the position, height and shape of the upstream wall 203, its restriction wall end 207, the downstream wall 204 and its restriction wall end 206 permits an adjustment of the concentrated spray region 701 and the thin spray region 702 in a manner which could not be achieved by the prior art Figs. 3-5 or the cited Miyajima references. These relationships were not realized until the present invention was developed and, as such, are neither taught nor suggested by either of the Miyajima references.

Reconsideration and allowance of amended claims 1 and 2 over the Miyajima F2000A100 document and the Miyajima patent is respectfully requested. By the present Amendment, claim 1 has been amended to incorporate the subject matter of claim 4 while claim 2 has been amended to incorporated the subject matter of claim 5 (without prejudice to the Applicants' right to file a Continuation application directed to the broader subject matter of original claims 1 and 2, respectively). Each of the independent claims 1 and 2 defines a manufacturing method of a fuel injection valve that includes a restriction wall (such as 210 in Fig. 6) that includes two ends (such as 206 and 207) and a wall (e.g., 203) that extends from one end (e.g., 207) located in the upstream of the circling direction of the fuel. Claim 1, as amended, goes on to specifically define the feature of:

> "the positional relation between the concentrated spray area and the thin spray area is changed by varying the height or angle of the wall, and the position of the one end."

Claim 2, on the other hand, specifically defines that the positional relationship between the concentrated spray area and the thin spray area is changed by varying:

> "an angle, formed between a direction along which the wall extends from the end perpendicularly to the injection hole center axis

and a line which connects the two ends of the circumference of the restriction wall, from 180 degrees."

As such, each of the independent claims 1 and 2 clearly defines that by varying the recited features (such as the height or angle of the wall and position of the one end in claim 1 or the angle from 180°, as defined in claim 2) the positional relation between the concentrated spray area and the thin spray area can be changed. These features are completely lacking from either of the Miyajima references.

As discussed above, the Miyajima references both deal with arrangements in which the upstream and downstream step walls are both located along a straight line, with no adjustments being made in accordance with the features defined in claims 1 and 2 for controlling the positional relationship of the concentrated spray area and the thin spray area. As also pointed out above, the inventors did not develop these relationships between the respective walls and the positions of the ends of the restriction wall until after the teachings of the Miyajima references were developed. Indeed, as discussed in the Specification and throughout the proceeding discussion, the present claimed invention, as set forth in claims 1 and 2, serves as a distinct improvement over the arrangements shown in the Miyajima references. Therefore, reconsideration and allowance of amended claims 1 and 2, and the dependent claim 3, is respectfully requested.

Reconsideration and allowance of the independent device claims 6, 7, 8, and 9 and their respective dependent claims is also respectfully requested. In each case, these device claims define specific angular relationships with regard to the wall on the upstream side and a line connecting the two ends of the circumference of the restriction wall, which angular relationship is neither taught nor suggested by the

straight line arrangement (between step walls in the upstream and downstream portions) of the Miyajima references. For example, in the case of claim 6, the angular relationship is set forth of:

> "an angle, formed between a direction along which the wall extends from the end perpendicularly to the injection hole center axis and a line which connects the two ends on the circumference of the restriction wall, is made smaller than 180 degrees, when measured from the direction of the wall towards the line in the opposite direction of the circling of the fuel, viewing the tip of the fuel injection valve with the injection hole opening from the downstream of the spray injected from the injection hole."

This same limitation is contained in claim 7, together with additional recitations found in the last paragraph concerning the end (e.g., 206) located in the downstream of the restriction wall. These angular relationships are completely lacking from either of the Miyajima references. Similarly, the last paragraph of claim 8 and the last two paragraphs of claim 9 define angular relationships which are also completely lacking from either of the Miyajima references. The setting of these angular relationships permits the optimized adjusting of the location of the concentrated spray region and the thin spray region to avoid problems discussed above regarding the prior art arrangements shown in Figs. 3-5 and the Miyajima references. Accordingly, by virtue of these specific recitations of angular relationships set forth in independent claims 6-9 and their respective dependent claims 10-15, reconsideration and allowance of the device claims 6-15 is also respectfully requested.

If the Examiner believes that there are any other points which may be clarified or otherwise disposed of either by telephone discussion or by personal interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

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To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Antonelli, Terry, Stout & Kraus, LLP Deposit Account No. 01-2135 (Docket No. 503.41039X00), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

By _____
Gregory E. Montone
Reg. No. 28,141

GEM/dlt

1300 North Seventeenth Street, Suite 1800
Arlington, Virginia 22209
Telephone: (703) 312-6600
Facsimile: (703) 312-6666